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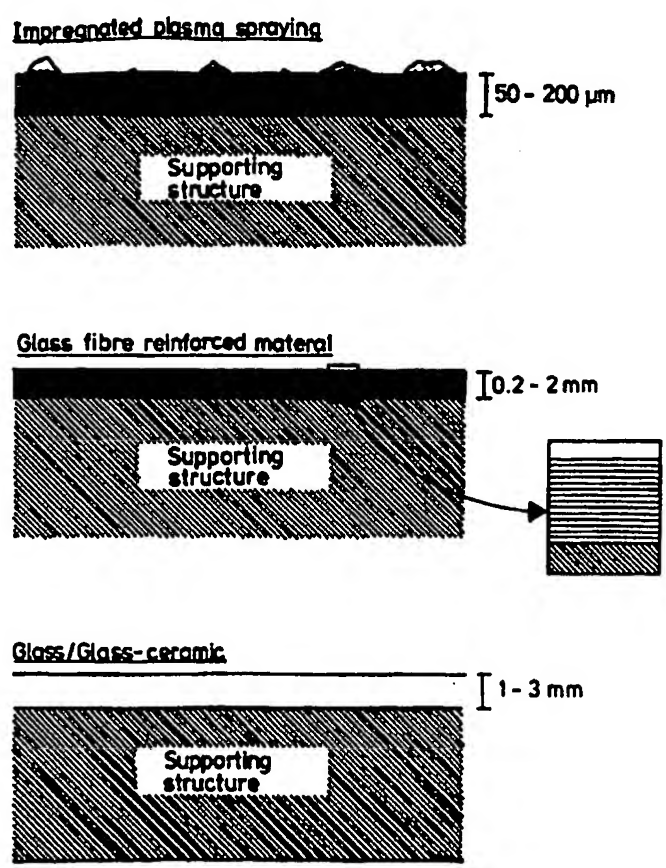
(54) Title: COOKING SURFACE

(57) Abstract

A cooking surface has a thickness which is decided by a compromise between the highest efficiency, the lowest magnetic stray field, and the desired surface material. In the thickness range 0.05 to 0.2 mm the top layer consists of plasma sprayed hard ceramic such as alumina, possibly impregnated with poly-tetra-fluor-ethylene. In the thickness range 0.2 to 2 mm the top layer may consist of a glass fibre reinforced material possibly impregnated with poly-tetra-fluor-ethylene, possibly of a hardened quality, and in the thickness range 1.00 to 3.00 mm the top layer may consist of a vitroceramic or glass material. Scratch resistance and cleanability are combined with an elevated efficiency.



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Cooking surface.

The invention relates to a cooking surface for an induction heating cooker comprising a coil structure below the surface.

Flat and heat tolerant upper surfaces for cookers are well known, and their use in domestic kitchens is predominantly due to the ease with which one may move cooking utensils from one to the other cooking zone, the ease of cleaning, and the quick thermal response. However, most of these are made selfsupporting of a glass or vitroceramic material which have to be quite thick in order to withstand the dropping of cooking utensils. The differences in coefficient of expansion between the top plate of said glass or vitroceramic material and the supporting metal frame make the manufacture complex and the cleaning of the edges of the top plate is rather more difficult due to the need to allow expansion with respect to the surrounding frame.

The fairly thick glass or vitroceramic top plates which have become known in connection with radiative heating zones have been carried over into the area of induction heating, mainly because of the well-established manner of manufacture, provision with patterns and signs and because the material combines electrical insulation with strength. The hampering in energy transfer due to the spacing between the transmitting coil and the cooking utensil has been accepted in view of the other advantages.

In WO94/05137 a cooking plate concept is described which utilises an induction heating arrangement comprising a ring-shaped magnetic core structure made of magnetically conductive concrete. This structure is embedded in further concrete material, and the top surface may be either cast upon the fairly solid base or be made of possibly porous alumina (aluminium oxide ceramic) which demonstrates a high thermal insulation and abrasion resistance. This latter material would be applied by plasma spraying. It is hence non-

selfsupporting. However, this kind of top surface material, although thermally excellent, has shown certain disadvantages in practice. The inherent porosity makes the surface difficult to clean, although very strong detergents may be used, due to the chemical stability of alumina. The casting in place of a top layer of heat resistant concrete is efficient in the manufacturing process, but the finishing of such a surface and the sealing of the pores to permit cleaning are difficult tasks and the result may be destroyed by detergents. Hitherto it has been considered that a top layer should be as thin as possible for efficient power transport, in other words, the air gap should be minimized. Hence all endeavours in this field have worked towards this goal. The structure described above provides this possibility in a most efficient manner, but at the cost of a very massive construction.

There is hence a need for an improved surface which does not display these disadvantages, yet still provide the functionality of a construction of the type described in said PCT publication.

This is obtained by applying the realization that the heating of the top surface is due to two contributions: losses in the induction energy transmitter which is embedded in the base at some distance from the upper surface of the heat insulating layer and conduction of heat from the heated cooking vessel via the heat insulating layer to the induction energy transmitter. Said heating actually increases the losses of the induction energy transmitter. In fact, it has surprisingly turned out that for each combination of permeability in the bottom of the cooking vessel and the range of power handled by the cooking zone there is a range of thicknesses of the top layer which provides an optimum of efficiency in the transfer of power from the cooking zone to the cooking utensil. It has turned out that such thicknesses all fall in the same absolute

range which is in all cases below the 3 mm which is in general industrial use today. The improved structure is characteristic in that the thickness of the cooking surface is chosen between 0.05 mm and 3 mm, preferably between 0.2 and 2.5 mm. The preferential distance also affords a good performance as regards magnetic field leakage. The specific thickness to be used in any particular combination of coil structures, operational frequency and cooking vessel range may be determined by the skilled person without undue experimentation.

In an embodiment of the invention the surface is particular in that it extends unbroken over the totality of the coil structures at least to the edge area of the cooking area. This will give certain advantages as concerns cleaning by washing and may be supplemented by raised edges formed in the same material.

A further embodiment extends directly from the basic idea of the invention in that the top layer has a limited area, though larger than a coil structure, and may be removeable but flush with the surrounding surface when fitted. This makes it possible to fit surfaces above the coil structure which may be changed when eroded, permanently soiled, or perhaps not fitting with the internal decoration of the kitchen area, all in all making this highly technological product much more adaptable to living conditions than previously known cookers.

Further embodiments of the invention adapts the material of the top surface to the thickness determined for the particular construction, viz. for the thickness range 0.05 to 0.2 mm the top layer consists of plasma sprayed hard ceramic such as alumina, possibly impregnated with poly-tetra-fluor-ethylene, and for the thickness range 0.2 to 2 mm the top layer consists of a glass fibre reinforced material, possibly impregnated with poly-tetra-fluor-ethylene, possibly of a hardened quality. For the thickness range 1.00 to 3.00

mm the top layer consists of a vitroceramic or glass material. These materials each combine good wearing qualities with good cleaning properties, however according to the invention they are so thin that they would not be able to support themselves over large areas, let alone carry cooking vessels.

A further material which may advantageously be used in embodiments of the invention is an organically modified ceramic material.

In order to permit the user to determine which coil structure (which cooking zone) has most recently been active, a further advantageous embodiment incorporates reversible heat-modifiable pigments into the surface. This is now feasible and with a wide range of fairly low-temperature pigments because the invention provides for a high efficiency and hence low losses and reduced heating of the surface itself.

The specified thickness and the consequent reduction of heating losses according to the invention makes it possible to construct an induction heating cooker with several cooking zones which is totally self-supporting, i.e. without brackets between the edge frame members and yet lightweight. This is obtained by a construction which is particular in that one or several transmitter coil structure or structures is/are embedded in a polymer structure which is composed with a compartmentalised underside and a plane topside incorporating shallow wells for exchangeable top layers above each transmitter coil. A similar embodiment uses a light alloy in stead of a polymer, with the specific advantage that stray fields from the coil structures are shielded or short-circuited.

It has furthermore been realized that it is possible to obtain a thickness in the upper part of the range and yet retain the materials for the lower part of the thickness range with the advantages particular to those materials in that the surface consists of a

protective layer and a number of projections directed upwards from said layer, the height of the projections defining the thickness of the cooking surface. There is no limitation to the area and number of these projections, however in case only very few are used, they must not be so sharp as to scratch the cooking utensils. Obviously a minimum number of three supporting projections are needed for a pot. The particular advantage of this embodiment must be seen in the layer of air which creates heat insulation between the bottom of the cooking vessel and the coil structure embedded in the cooker.

The invention will be described in greater detail in the following with reference to the drawings, in which

Fig. 1 shows the general relationship between efficiency and thickness of the top layer,

Fig. 2 shows the general relationship between the magnetic B field surrounding a pot on an induction heating cooker in dependence of the thickness of the top layer,

Fig. 3 shows structures for top surfaces according to the invention, and

Fig. 4 shows a structure in which an air space supplies heat insulation between the bottom of a pot and the induction heating coil structure.

The basis for the invention resides in an observation that the practical efficiency (determined as output power versus input electrical power) of an induction heating cooker is dependent on the distance between the top of the coil structure including the core parts and has a maximum, the sharpness of which is dependent on the actual construction but with the general feature that thicknesses in the range 0.05 to 3 mm cause a higher efficiency than thicknesses outside this range. A general curve displaying this relationship is shown on Fig. 1. Similarly it has been observed as

shown on Fig. 2 that the induction field B surrounding a pot on an induction heating coil structure increases with distance at relatively small distances. Hence there may surprisingly be found is a distance which is a suitable compromise between the highest efficiency, the lowest magnetic stray field, and the desired surface material.

In Fig. 3 is shown embodiments of the invention corresponding to the relevant thickness ranges. It is advantageous to let the surface layer extend outside the position of the induction coil structures, and hence the embodiments are generally shown to be supported by the "supporting structure".

In Fig. 4 is shown an embodiment which displays high strength and cleanability combined with the creation of an air gap which would normally only be obtained in an extremely porous structure. The supporting structure carries an upper surface made of alumina or similar composition which displays rounded projections, the number and distribution of which is dependent on the desired appearance of the top. The area of the individual projections may be selected according to e.g. the types of pot and may be ribs, possibly in a radial distribution.

PATENT CLAIMS

1. A cooking surface for an induction heating cooker comprising a coil structure below the surface, characterized in that the thickness of the cooking surface is chosen between 0.05 mm and 3 mm, preferably between 0.2 and 2.5 mm measured between the top of the coil structure and the bottom of the cooking vessel.

2. A cooking surface according to claim 1, characterized in that it extends unbroken over the totality of the coil structures at least until the edge of the cooking area.

3. A cooking surface according to claim 1, characterized in that the top layer has a limited area, though larger than a coil structure, and may be removeable but flush with the surrounding surface when fitted.

4. A cooking surface according to claim 2 or 3, characterized in that in the thickness range 0.05 to 0.2 mm the top layer consists of plasma sprayed hard ceramic such as alumina, possibly impregnated with poly-tetra-fluor-ethylene.

5. A cooking surface according to claim 2 or 3, characterized in that in the thickness range 0.2 to 2 mm the top layer consists of a glass fibre reinforced material possibly impregnated with poly-tetra-fluor-ethylene, possibly of a hardened quality.

6. A cooking surface according to claim 2 or 3, characterized in that in the thickness range 1.00 to 3.00 mm the top layer consists of a vitroceramic or glass material.

7. A cooking surface according to claim 1, characterized in that the top layer consists of an organically modified ceramic material.

8. A cooking surface according to claim 1, c h a r a c t e r i z e d i n that the top layer incorporates reversible heat-modifiable pigments.

9. A cooking surface according to claim 1 or 2, c h a r a c t e r i z e d in that shallow wells are provided for exchangeable top layers above each transmitter coil.

10. A cooking surface according to claims 1-3 and 9, c h a r a c t e r i z e d i n that one or several transmitter coil structure or structures is/are embedded in a polymer structure which is composed with a compartmentalised underside and a plane topside incorporating shallow wells for exchangeable top layers above each transmitter coil.

11. A cooking surface according to claims 1-3 and 9, c h a r a c t e r i z e d i n that the transmitter coils are fitted into a self-supporting light alloy structure with a plane topside incorporating shallow wells for exchangeable top layers above each transmitter coil.

12. A cooking surface according to any of the claims 1 to 7, c h a r a c t e r i z e d i n that the surface consists of a protective layer and a number of projections directed upwards from said layer, the height of the projections defining the thickness of the cooking surface.

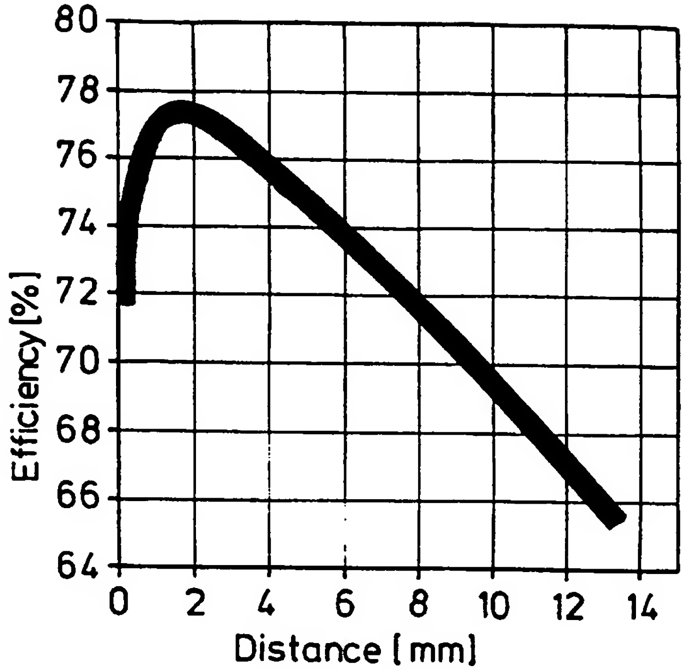
80
78
76
74
72
70
68
66
64
Efficiency [%]
0 2 4 6 8 10 12 14
Distance [mm]

FIG.1

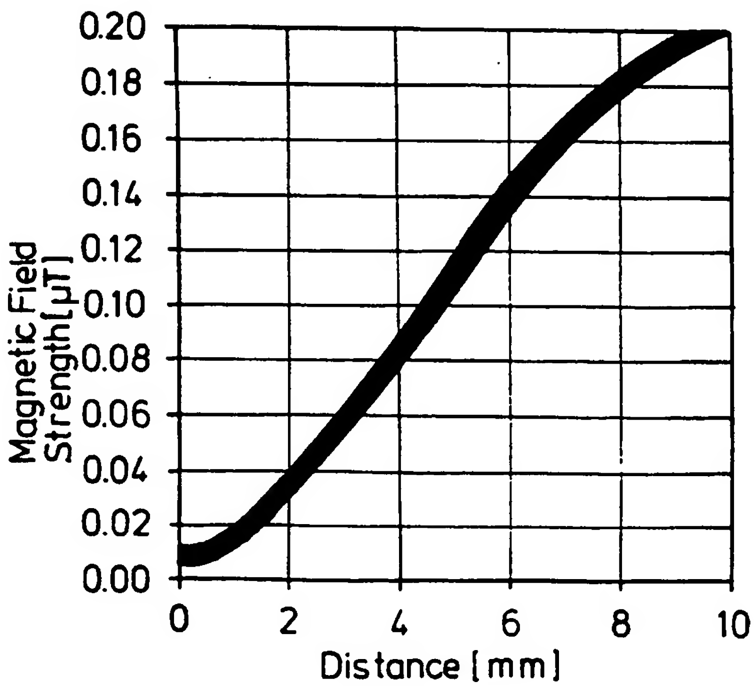
0.20
0.18
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
Magnetic Field Strength [μT]
0 2 4 6 8 10
Distance [mm]

FIG.2

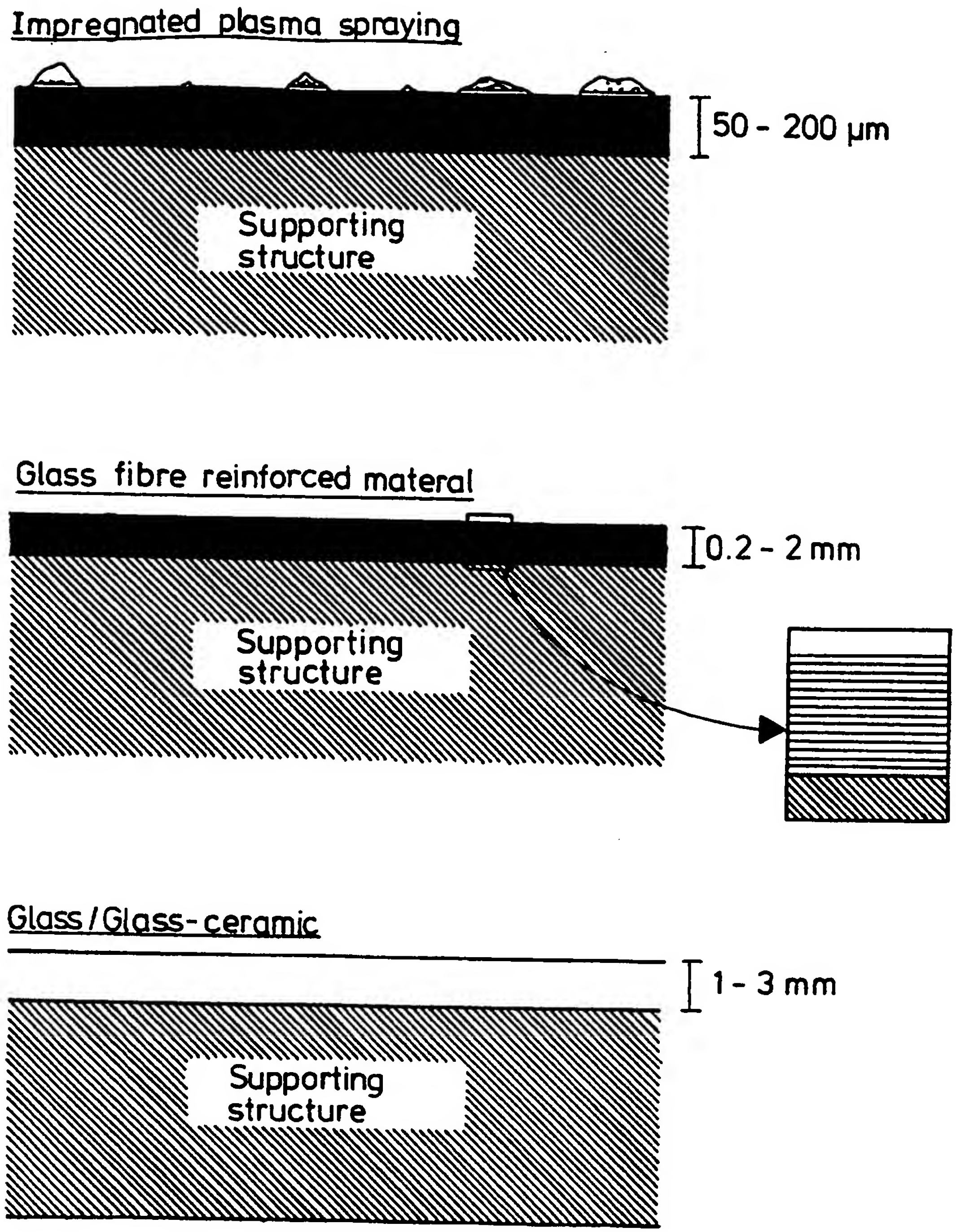
Impregnated plasma spraying
50 - 200 μm
Supporting structure
Glass fibre reinforced materal
0.2 - 2 mm
Supporting structure
Glass / Glass-ceramic
1 - 3 mm
Supporting structure

FIG.3

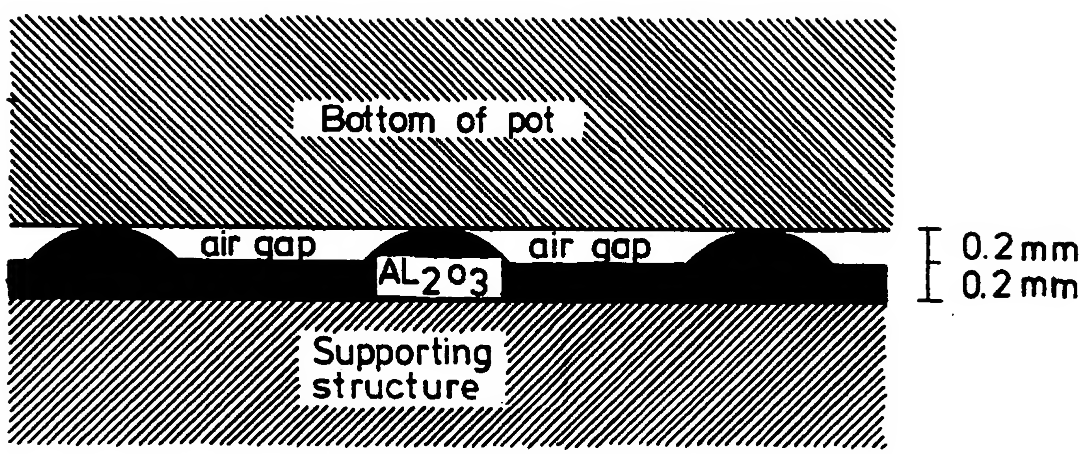
Bottom of pot
air gap
air gap
AL2O3
0.2mm
0.2mm
Supporting
structure

FIG.4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 96/00169

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H05B 6/12
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9405137 A1 (A/S ERNST VOSS FABRIK), 3 March 1994 (03.03.94) -- --------	1

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

Information on patent family members

05/09/96

International application No.

PCT/DK 96/00169

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO-A1- 9405137	03/03/94	AU-A- 4699893	15/03/94
		CA-A- 2143197	03/03/94
		DK-A- 105192	22/04/94
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